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OBSERVATIONS ON CERTAIN EXTRA-INDIAN ASIATIC COTTONS

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Introduction.

The cultivation of cotton is restricted to tropical and sub-tropical countries, and the limiting factor which prevents cultivation in more northerly regions is one of temperature. A second factor of equal importance, in that it may assume the position of a limiting one, is moisture. Though the natural moisture is, in many cases, reinforced by irrigation, and cotton is consequently grown in tracts where the rainfall is deficient, in other tracts this is not so and here cultivation will be restricted to the regions of sufficient rainfall. Throughout Asia, from Arabia in the West to China on the East, cotton is grown wherever sufficiently favourable climatic conditions are to be found. There is thus a continuous tract of country bordering the Northern limit throughout which cotton is found to a greater or less extent, and of which Northern India forms the central portion, separated from the two wings by the mountainous country of Afghanistan and Assam. To the West lie Persia and Arabia, separated by no marked geographical or climatological feature from Egypt, and to the East the countries of Siam and China. From this aspect Northern India more nearly agrees with these countries

than with Southern India, from which it is separated by no marked geographical feature, and where the limiting factor to cotton growth is one of moisture. It appeared, therefore, a matter of some interest to compare the cottons of Northern India with those grown to the East and to the West, and in consequence an attempt was made to grow as representative a collection of cottons from these regions as could be obtained.

Through the courtesy of Col. Prain, F.R.S., Director, Royal Botanic Gardens, Kew, seed was received from countries extending from Persia on the West to China on the East, and this was grown during the seasons of 1910-1911. To Col. Prain as well as to the various Consuls in Persia, too numerous to mention individually, to the Siam Department of Agriculture and to the Superintendent, Botanical and Forestry Department, Hong-Kong, from whom the numerous samples of seed have been received, the writers desire to record their indebtedness.

(1) THE PERSIAN COTTONS.

These cottons, as far as they have been observed, fall into two groups. The first of these includes those types falling into Todaro's group *Sub-sectio Indica* (Watts' Section II, Fuzzy Seeded cottons with United Bracteoles), which may be termed the Asiatic group of cottons, while the latter belongs to that author's *Sub-sectio Magnibracteata* (Watt's Section III, Fuzzy Seeded cottons with free Bracteoles). To this latter belong those types which are found widely cultivated in Egypt and America, and members of this group are also found in India. The representatives of this latter group, both in India and Persia, are most closely allied to the American types of Upland Cotton, *G. hirsutum*, L. That this is so in the case of India is not surprising. For more than a century there have been repeated importations of cotton seed from America which have left their mark on the country in the wide distribution of scattered plants of this type, though its cultivation on an extended scale is only here and there maintained. The presence of this type in Persia is not so readily understood. The transportation of seed of agricultural plants has constituted a marked feature of caravan routes in time past, and in countries where these form the sole line of intercommunication, and it is, therefore, somewhat surprising that the Egyptian types, with their great reputation, have not found their way to Persia by this means. The single recorded case of an attempt to grow the Egyptian plant appears to have resulted in failure (*see* below, p. 109).

The types belonging to the former group are not numerous and are all closely related to *G. herbaceum*, Linn. This specimen is described under this name by Parlatore* and Todaro,† by the

* Sp. dei Cotoni.

† R. I. Cult. dei Cotoni.

former of whom it is accurately illustrated.* It is probably one of the earliest known in cultivation and is the form found in certain of the countries bordering the Northern Mediterranean coast, including the Crimea, South Italy, Sicily and Spain. Its home appears to be in Mesopotamia whence it most probably spread to these countries.†

In India a plant which is in many respects closely similar, and is described by Gammie‡ under the same name, though placed by Watt§ under *G. obtusifolium*, Roxb., is found in the Bombay Presidency and yields the so-called long-stapled cottons of India, such as Broach. From this, however, the Persian types differ in one important point, namely, the character of the secondary branches. In more than one earlier publication‖ attention has been drawn to the difference between the vegetative and reproductive branches of the cotton plant, and to the relation which exists between the length of the vegetative period and the type of the secondary branches. The vegetative branches are monopodial and, consequently, if the secondary branches are sympodial, the plant will commence to flower as soon as these are formed. If, on the other hand, these branches are monopodial, flowering will be delayed until the appearance of the tertiary branches. Roughly, this difference in the length of the vegetative period may be placed at below 100 days for types with sympodial secondary branches, and at 200 days or over for those with monopodial secondary branches.

A difference of like nature is found to occur between the Indian and Persian types of the series now under consideration. In the Indian types the secondary branches are monopodial and the types consequently late flowering; while, in the Persian types, these are, with the exception of a few basal branches, all sympodial, and these types are, therefore, relatively early flowering. In this difference lies the explanation of the cultivation,

* Rel. Cult. dei Cotoni. Tav. I.

† Watt: The wild and cultivated cottons of the world.

‡ The Indian Cottons; Memoirs, Dept. of Agr. in India, Bot. Series, Vol. II, No. 2.

§ *Loc. cit.*

‖ *Jour. As. Soc., Bengal*, New Series IV (208), 1; *Journal of Genetics*, I (1911), 3.

near the northern limits of cotton production and in a country characterised by a comparatively short hot weather and by a cold winter of types, which, in the forms known to the author, were characterised by their prolonged vegetative period. From the details of cultivation which were, in many cases, kindly submitted with the seed, it appeared that the vegetative period did not, in Persia, exceed 120 days. It was further apparent from these details that the custom of breaking off the apex of the main stem is common, if not general. Such action naturally promotes an increased development of secondary branches and also an early production of tertiaries to which this early habit might be attributed. The information was not, therefore, sufficiently definite to outweigh the impression, earlier formed, that these cottons would prove to have an extended vegetative period and the seed was sown early in the season (May 4th), with the object of procuring a lengthened season for the development of reproductive branches before the cold weather set in. Experiment has, however, proved this to be incorrect and, in consequence of the early sowing, considerable injury resulted from the coincidence of the flowering period with the rains.

Such, in outline, is the main characteristic of the *herbaceum* series of Persian cottons. A closer inspection, however, discloses certain points of considerable interest which again centres in the habit of the secondary branches.

In the Indian cottons the secondary branches are either pure monopodia or pure sympodia. In the latter case the apical bud develops at each node into a flower bud, vegetative growth being continued by the development of the main axillary bud. In the Persian forms, on the other hand, the development of the apical bud does not invariably take the form of a flower bud. Here the growth of the apical and axillary buds into two vegetative shoots of approximately equal vigour may result, in which case the shoot arising from the apical bud will be displaced from the direct line of growth of the shoot owing to the vigorous growth of the axillary bud (Plate I). But such equality does not always result, in some cases it is the development of the apical bud that is more

vigorous, in others that of the axillary bud. It is, therefore, possible to consider such branches from a double aspect. In the first instance the development of the apical bud forms the branch, which is, thus, a monopodium bearing tertiary branches; in the second, the branch is formed of the internodes developed from the successive axillary buds, with false tertiary branches developed from the apical buds. The difficulty of determining which of these two definitions most accurately describes the condition is most marked when this dual development takes place at the first (proximal) node of the branch and the two limbs are equally developed. Frequently, however, this does not occur till the second node and in such cases the secondary branch definitely starts as a monopodium (Plate I).

Such a development is totally distinct from, though in outward appearance, owing to subsequent torsion, very similar to, a condition frequently met with in the Indian types, especially *G. cernuum*, Tod. Here the accessory bud of the sympodium develops (Plate II). The branch produced from this bud is invariably a monopodium and if, as frequently happens, the flower bud formed by the development of the apical bud falls, the condition can only be distinguished by the presence of the scar.

Occasionally the dual development, or false dichotomy, takes place at a series of successive nodes (Plate III). In such cases the branch is most aptly termed a sympodium, for otherwise the tertiary and subsequent branches must all be considered monopodia—a condition which has not been observed in any of the *Gossypia* studied. In isolated cases the branching becomes still more diverse. Plate IV illustrates one such instance. In this case the secondary branch is composite. The axillary bud at the second node carries on the growth, the apical bud giving rise to a weak monopodium only. The branch illustrated in Plate V is still more complex; considered as composed of the stronger of the shoots arising at each node, it starts as a sympodium, continues as a monopodium with a series of sympodial tertiary branches and ultimately ends in a sympodium.

These forms probably constitute a link—lacking in the Indian cottons—between the monopodial types, in which the secondary branches are pure monopodia and the sympodial types with pure sympodial secondary branches. From the description given by Todaro of his *G. herbaceum* it is clear that the plant to which he refers is a sympodial type. He says they (the branches) "grow in a zig-zag tortuous manner, one internode making a small angle with another," a description which accurately defines the form of a sympodial branch, but from his description of *G. wightianum* it is not clear whether this plant has monopodial or sympodial secondary branches. There appears to be small doubt that the Persian types approach, and in certain cases very closely approach, the form grown in Southern Europe and described by Todaro as *G. herbaceum*. The form from S. Europe is only known to the authors from an entire plant preserved in the herbarium of the Botany School, Cambridge University; in this only sympodial secondary branches are developed.

In this diversity of the form of secondary branching is to be found the most distinctive character of the various Persian types, but in one other feature also they appear to differ with some definiteness. In all observed species of *Gossypia* there occur two buds in the axil of each leaf, one of which is the main axillary bud, and to this the other is accessory and lateral. This accessory bud may remain dormant or may develop and, in the latter case, gives rise to a monopodium (Plate VI). In certain types development of the accessory bud appears to be a definite feature, and in many cases the branch thus produced is far more vigorous than that developed from the main bud. This is especially marked where the main axillary bud forms a sympodium, which is, in such cases, frequently reduced and in extreme cases withered. The true relation of the branches is, here, readily determined by close inspection from the fact that the smaller branch is sympodial—a condition which has never been found in the branch from an accessory bud—and from the relative position of the two branches. As has been shown, the position of the accessory bud in relation to the main axial bud is constant

for a particular branch. From the upper branches the relative position of the main and accessory buds may be determined, and from this the main or axillary nature of the branches situated lower on the stem ascertained.

Lastly, a single instance has been found of a type in which the plant appears to possess two sympodial branches arising from the same leaf axil, one of which develops strongly, while the second gives a single, or at most two, nodes bearing flower buds. This condition appears at first sight to constitute an exception to the rule that the accessory bud gives rise to a monopodium only. At the base of the second, or dwarf, sympodium, on the side removed from the main sympodium, occurs a small leaf or bract, while between the two branches is found a bud. This bract, therefore, constitutes the first leaf of a monopodium developed from the accessory bud, and of which the first internode is reduced and the apical development arrested. The sympodial branch which apparently arises from the accessory bud is, thus, in reality, the tertiary branch arising from the axil of the first leaf of a much reduced monopodium. The same development is found at many of the nodes of the secondary sympodial branches, the accessory bud here giving rise to an apparent sympodium (Plate VII).

Further differences have been observed in the length and thickness of the sympodial branches. In the typical form the internodes are relatively short and the branch is of limited growth. The branch thus formed is spreading or slightly ascending. In certain cases, however, there occurs a marked development of secondary thickening. The branch in these cases loses the 'zig-zag' habit described by Todaro and, owing to the additional rigidity thus obtained, becomes sharply ascending. In general appearance the plant resembles the pure monopodial form found in India, from which, however, it is quite distinct. It has, moreover, a long vegetative period, for where such secondary thickening occurs, the apical bud either fails to develop entirely or withers after a rudimentary flower bud has been formed. In other cases the branches continue to develop,

but remain thin with relatively long internodes. Such branches are incapable of supporting their own weight and the plant becomes definitely scandent.

The fruit is invariably globular, with a sharp mucronate apex, and more or less covered with small glands which appear as black dots. In one instance the fruit was markedly distinct. In size it was considerably larger than the typical fruit, without glands and suffused with a rich red colour.

Owing to the climatic conditions under which they were grown, the produce was small and in several cases nil. It has been found impossible, therefore, to deal with the lint characters of this series. Certain forms, however, are characterised by the possession of a khaki coloured lint, and in this particular differ from the majority of the forms in general cultivation.

From the observations of which the main features have been given above, this series of cottons may be provisionally grouped in the following manner. That this classification can be considered final is not suggested. The observations on which it is based have been limited to a single season, and it is not known how far the characters relied on for division are definite and inherited. Nevertheless there are not wanting signs that these characters are of this nature and distinct, for in many cases the samples sent appear to be nearly pure and true to one type or the other, a condition which is not readily associated with variation in the characters used for the determination of purity.

'HERBACEUM' SERIES OF PERSIAN COTTONS.

(*a*) Apical bud at each node of the secondary branch developing into a flower bud—

(1) Sympodial branches weak and having the typical zig-zag manner of growth described by Todaro ... ... *Type* 1

(2) Sympodial branches, at least the lower ones, strong with marked secondary thickening owing to which the branch becomes straight and simulates a monopodium ... ... *Type* 2

(3) Characters as in (1) but with a marked development of the accessory buds as monopodia ... ... *Type* 3

(4) Accessory buds in appearance developing as sympodia ... *Type* 4

(*b*) One or more apical buds of the sympodium developing into a monopodium, giving to the branch an appearance of dichotomy.

Accessory bud dormant—

(1) ... ... *Type* 5

Accessory bud forming a monopodium—

(2) Branches erect or spreading ... ... *Type* 6

(3) Plant scandent ... ... *Type* 7

(4) With characters of (2) but with large red eglandular fruit ... *Type* 8

It appeared possible at first to distinguish two types of dichotomous branching according to whether this takes place at the first or second node of the secondary branch. Though, however, there appears to be a definite tendency in many cases for this development to take place at the same relative node in any particular plant, and in their extreme development the two characters are quite distinct; intermediate forms, in which no such definiteness is apparent, are not uncommon. The division cannot, therefore, be made without further investigation of the point.

In the above table reference to the series of cottons with khaki lint has been omitted. The whole of this series suffered severely from the excessive humidity of the rains, and in several cases it has been impossible to identify the type to which they belong. It cannot be said, therefore, with any certainty whether each, or only a few, of the above types is represented by a race with khaki lint.

The second group of Persian cottons are, as has been noted above, related to the American *hirsutum* forms. The main character in which they appear to differ is in the fuzz which may be present or absent and, in the former case, white or green. There appear to occur considerable fluctuations in the length of lint.

THE COTTONS OF WESTERN PERSIA.

1. Received from H. B. M.'s Consul, Kermanshah.

As far as information is available, this is the only kind grown in this district.

The crop consisted of a mixture of Types 5, 6 and 8, of which type 5 preponderated. In this sample only were a few specimens of Type 8 found.

2. Received from H. B. M.'s Consul, Ahwaz.

A sample of cotton grown in Dizful. Noting on this and the two subsequent samples, he writes :—

"Sowing takes place from the 21st March to 21st April. The seeds are first cleaned of all adhesions of cotton, the presence of which, the Persian cultivators say, prevents germination. The ground is ploughed to a depth of 4" and watered. The seed is then sown and the ground harrowed over. Sprouts show in 6 days and the cotton is picked about 3 months later, the ground being irrigated in the interim.

Plants last two seasons, after which they are renewed."

The sample consisted of Type 5, and in nearly every case the false dichotomy took place at the second node. Associated with this were a few plants of the *hirsutum* form with fuzzless seeds.

3. Received from H. B. M.'s Consul, Ahwaz.

Cotton grown at Dizful where it is termed Parbat-i-Hindi (Indian cotton). The seeds are said to have been obtained from India.

This is a *hirsutum* type with naked seeds. The sample also contained a few fuzzy seeds which gave plants in other respects similar to the main crop.

4. Received from H. B. M.'s Consul, Ahwaz. Cotton grown at Shushtar.

The crop proved to be a mixture of Types 1, 3 and 5, only a small proportion of the latter, however, being present.

5. Received from H. B. M.'s Acting Consul, Mohammerah

Cotton grown in the vicinity of Shushtar and known locally as *Katti*. This sample consists of a mixture of Types 5 and 6 ; from it have been obtained plants with the most complex series of branching including those to which reference has been made above.

6. Received from H. B. M.'s Acting Consul, Mohammerah.

Cotton grown in the vicinity of Shushtar. As suggested by the sender, this proved to be the same as the last, a mixture of 5 and 6.

7. Received from H. B. M.'s Consul, Ahwaz.

The crop consisted of Type 1 in a nearly pure condition, a few plants only of Type 3 being present.

8. Received from H. B. M.'s Vice-Consul, Bushire. Concerning this cotton the following information was supplied :—

"I am told it is the usual and practically the only kind grown at Bushire, where the cultivation is now very reduced and restricted to a small part of the island."

"The seed is sown in spring and the pods will be ready for picking the summer of the following year."

The crop consisted of a large proportion of Type 2.

9. Received from H. B. M.'s Acting Consul, Shiraz.

Concerning the cultivation of this cotton the following information has been kindly supplied :—

"Sowing takes place 40—70 days after Nauroz (March 21st). Plough 3 times, manure if required (human if obtainable). Sow either (*a*) in furrows after 2 ploughings and then turn over furrows with plough ; or (*b*) after 3 ploughings, soil being then divided up into 'kurzehs,' seed thrown in soft soil."

"Clean seed with ashes."

"Water once, level off with ox beam. Water again after about 40 days. Weed carefully. Water once every 12 days and keep weeded. After 4th watering pick off top

buds to make plant widen out; towards the end of Mizan (October 24) water is cut off and plucking begins some 10 days later."

"There is only one kind of seed."

"Diseases—Shifteh شفته (*a*) attacks the stem and withers the plant; (*b*) attacks the bolls." (I have not seen this; it seems to be a blight.)

"Worm Riha (رحه (? Bollworm) usually due to bad manure, especially horse and donkey."

The crop appeared to be composed entirely of Type 7.

COTTONS FROM CENTRAL PERSIA.

10. Received from H. B. M.'s Vice-Consul, Resht.

Cotton known as Velayti or local and grown in the Province of Mazanderan.

This cotton was much damaged by the rain. It appeared, however, to consist almost entirely of Type 2

11. Received from H. B. M.'s Vice-Consul, Resht.

Sample of cotton from Irak and supplied under the name of 'Iraki.'

This sample consisted of a *hirsutum* form with fuzzless seed.

12. Received from H. B. M.'s Consul-General, Isphahan.

Cotton from Kashan known as 'Malleh.' Of this cotton it is noted that "it is the most expensive and is very little grown, as this plant produces far less pods than the other kinds, the texture of the cotton being finer and more silky. I am told that no amount of washing or bleaching will change the colour."

The entire series of plants developed from this sample of seed showed the branching characteristic of Type 4 as described above. The lint is khaki in colour.

13. Received from H. B. M.'s Consul-General, Isphahan.

Cotton from Kashan known as 'Shikari.' Of this it was also noted that the cultivation is limited.

This cotton is of Type 3 and possesses a khaki lint.

14. Received from H. B. M.'s Consul-General, Isphahan.

Cotton from Kashan known as 'safed.'

This crop consisted of a large proportion of Type 4 but contained also Type 1.

15. Received from H. B. M.'s Consul-General, Isphahan.

Cotton from Murchikhat. This and the subsequent cotton are reported to be the two best kinds grown in the Province.

The crop proved to consist of Type 5 with a few plants of Type 1.

16. Received from H. B. M.'s Consul-General, Isphahan.

Cotton from Murchikhat.

The plant was the scandent form, Type 7.

17. Received from H. B. M.'s Consul-General, Isphahan.

Cotton from Sultanabad.

The crop consisted of nearly pure Type 1 intermingled with which were a few plants of Types 3 and 5.

18. Received from H. B. M.'s Consul, Sultanabad.

Cotton of the Sultanabad district.

The crop consisted of Type 2.

19—23. Received from H. B. M.'s Vice-Consul, Yezd, through the Consul-General, Isphahan.

Of these samples the following information has been provided.

"The method of cultivation of each kind appears to be identical."

19. "A low bush, short staple, prolific of pods. Cotton known as Kuluzeh.

The plant which is of the *herbaceum* type could not be identified further owing to the damage caused by the rains

20. "Taller (than the last), has to be pinched to stunt it, it is less prolific, but has a longer staple. Known as Vush."

This crop was also badly injured by the rains. It appears to be largely composed of Type 5.

21. "Dirty white seed of similar properties."

"Known as Vush-i-Shikari.

The crop appears to be identical with the last. As, however, no seed set, a comparison of the lint was not possible.

22. "A brownish seed giving brownish wool which is much liked by the village Parsis on account of being the natural colour of their clothing."

"Known as Mahalleh."

Owing to the injury caused by the rains, it was quite impossible to further identify the plant than as of the *herbaceum* type. The lint is of a rich khaki colour.

23. "A tan-coloured seed giving tan-coloured wool, low bush, short staple, small cropper but sought after."

"Known as Surkesh."

This crop also could only be identified as belonging to the *herbaceum* group.

24—27. Received from H. B. M.'s Consul-General, Isphahan.

Cottons grown in the neighbourhood of Isphahan.

24. "Superior quality grown at Khourazgan due East of Isphahan on the road to Yezd."

"Known as Kagazi, *i.e.*, papery."

The crop proved to be pure Type 7.

25. "Superior quality. Grown in the Linjani district, a highly irrigated tract, S.-W. of Isphahan."

"Known as Linjani"

Appears to be pure Type 1 but suffered during the rains.

26. "Medium quality. Grown in the district of Upper and Lower Jarqoyeh, South of Isphahan."

"Known as Par-i-Siyavushi (Adiantum capillus Veneris)."

This does not appear to differ from No. 24, being a distinctly scandent form.

27. "Medium. Grown in the district of Bul khar or Bur khar, North of Isphahan."

"Known as Bul khari or Burkhari."

This is again the scandent form and does not appear to differ from No. 24.

COTTONS FROM NORTH-EAST PERSIA.

28—30. Received from H. B. M.'s Consul, Turbat-i Haidari.

28. The crop consisted of Type 2 intermingled with which were plants of the *hirsutum* form with both fuzzy and fuzzless seeds.

29. Crop similar to the last but without the *hirsutum* form.

30. The crop proved to be nearly pure Type 3.

31—34. Received from H. B. M.'s Consul-General, Khorasan.

31. Cotton from Meshed.

The crop consisted chiefly of Type 5 with a few plants of Type 6. This sample has proved the most resistant of all to the effects of excessive rainfall.

32. Cotton from Meshed.

The crop was a mixture of a larger proportion of the *hirsutum* type with fuzzy seeds, a few fuzzless seeded forms and a few *herbaceum* forms belonging to Type 6.

33. Cotton from Herat.

The crop was a mixture of Types 1 and 3 of which the latter preponderated.

34. Cotton from Herat.

This was found to be pure Type 3.

35—38. Received from H. B. M.'s Consul for Seistan and Kain.

Concerning the cottons Nos. 35—37 H. B. M.'s Vice-Consul, Birjand, writes as follows :—

"Clayey soil is preferable. The ground is prepared just as for wheat. In a climate resembling that of Quetta the seeds are sown about the 10th April."

"For sandy soil, after sowing, the fields should be watered on the 32nd, 48th, 56th and every following 12th day.

"When the plants are about 10 inches high the tops should be broken off.

"Note :—Duroh is situated near the Perso-Afghan frontier, Latitude 30′ 15″, Longitude 60′ 30″."

35. Cotton "grown in Duroh from seed imported from North-West Afghanistan (Herat)."

"4lbs. cotton pods produce 1lb. cleaned cotton."

This appears to be a mixture of Types 2 and 3, the latter preponderating.

36. Cotton "grown in Duroh from seed imported from Western Afghanistan."

"4lbs. cotton pods produce 1lb. clean cotton."

This sample was labelled Coarse Kalakah.

The crop contained Type 5 with a few plants of Type 6.

37. Cotton "grown in Duroh from Persian seed."

"5lbs. cotton pods produce 1lb. cleaned cotton."

This appears to be pure Type 1 but suffered somewhat from wet

38. Cotton grown in Khusf. It is reported to be a very good cotton.

As far as this could be identified, it consisted of Type 5. The crop suffered severely from excessive moisture during the rains.

In response to a wish expressed by some of those who have been kind enough to supply the above samples of seed, a few brief observations on the Persian Cottons are appended. In doing so, it is fully recognised that the observations can only be of a tentative nature. In the absence of any personal acquaintance with the country under consideration it is impossible to speak with any large amount of authority. Though it has been possible, by the growth of these samples, to gather a certain amount of information about the types grown, their behaviour

under the very different conditions which obtain in Persia cannot be estimated. Nevertheless there appear to be certain well defined features which call for comment, and, bearing in mind the limitations imposed, may be detailed here.

As has been noted above, there are two distinct groups of cottons, one of which may be termed the indigenous group. Though composed of various sub-groups or types, these have certain characters in common, a fact which receives recognition in their association under the same specific name, *G. herbaceum*. One of these characters is to be found in the manner in which the fruits ripen. When the boll opens, the segments of the fruit part and the cotton protrudes through the opening thus made. In all the *herbaceum* forms of cotton this opening is slight and the protrusion of cotton consequently small. The cotton is, therefore, with difficulty gathered in a clean state. Usually it is accompanied by a large amount of 'dirt,' consisting of the withered bracts and carpel walls, owing to the presence of which the market value of the cotton is much reduced. The extent of this depreciation and the advantage of clean picking are indicated by the following report on two samples of lint sent by H. B. M.'s Consul for Arabistan and which were kindly valued by the Manager of the Cawnpore Cotton Mills. Both samples belong to cottons of this series.

"A. This is a good cotton, has a fine silky fibre and is fairly even and strong, it will spin successfully 16's to 20's. If it was free from leaf, it would to-day sell at 34/- to 35/- per 100 lbs. at Cawnpore; its present value is about 32/ to 33/ per 100 lbs."

"B. This is very dirty cotton and has some stained and damaged fibre in it. The spinning qualities of the fibre are fairly good and they are better than Bengals. Counts from 12's to 16's could be spun from it. If the cotton was clean, it would to-day be worth 30/ to 32/ per 100 lbs. in Cawnpore; in its dirty state it would sell for 23/ to 24/- per 100 lbs."

In the latter case there is, therefore, a depreciation of about 25 per cent. in value due to dirt.

There is, as above shown, a considerable variation in the habit of the different types and, in as much as in a climate with

a short season the yield largely depends on the number of sympodial branches which alone bear fruit, it would appear that certain types are more suitable than others. In this respect Type 2 appears to be the least suitable. Owing to the secondary thickening of the sympodial branches, these are practically infertile. The fertile portion of the plant is therefore limited to the apices of these branches and the tertiaries borne by the branch developed from the accessory bud. Not only, therefore, is the fertile portion of the plant limited, but it is developed after a long vegetative period.

Those types in which a marked development of the accessory bud takes place are also somewhat late in bearing. Owing to the vigour of the accessory shoot, the main sympodial shoots, especially the lower ones, are very reduced and even wither. Little fruit is borne, therefore, until the tertiary branches of the accessory shoot develop.

From the above quoted report it is clear that these types of cottons could be considerably improved by more careful picking. The difficulty is one which is inherent in all forms of *herbaceum* cottons and leads to the question of the possibility of growing kinds which are not of this form. From the above review it is clear that no other form is indigenous to Persia, so that the problem resolves itself into the question of the possibility of importing some foreign cotton. The review of the cottons already found in Persia indicates that a plant of the *hirsutum* type is already well established in the country. It would appear, however, to have undergone a certain amount of "degeneration." The possibility of establishing a plant of this type which will not undergo this degeneration or of establishing the more valuable Egyptian type naturally suggests itself. Indian experience does not give much hope for anticipating success in the former. In the appendix is given for comparison a statement of the rainfall and temperature data for a series of stations in Lower Egypt and Persia. There appears to be a marked similarity between the two countries in this respect. It seems reasonable, therefore, to anticipate the possibility of establishing the cultivation

of the Egyptian type of plant in at least some of the lower tracts of S. W. Persia where irrigation is assured. That this suggestion may not lead to false hopes and subsequent disappointment it is desirable here to draw attention to the difficulties attendant on efforts at acclimatisation; a subject which has received treatment elsewhere.*

The only definite information received concerning the suitability of the Egyptian cottons is derived from H. B. M.'s Consul-General, Isphahan. On this subject he writes of a conversation with a Parsee that the crop from Egyptian seed which was planted in Rafsenjan, "did not properly ripen owing to the cool weather coming on too quickly for it; he said they only got 20 *mans* where the ordinary kind would have given 150. The cotton produced was much finer and longer than the ordinary kind and sold for 1 *kran* a *man* more in Bombay, but, on the other hand, ordinary cotton will stand 14—20 days without water, whereas this required it every 7; that in the native plant, besides the wool the seeds are good for cattle which will also eat the leaves and stalks, but will not eat the Egyptian."

This attempt appears to have failed, but the district in which it was undertaken differs somewhat from that to which these remarks especially apply.

* Mem., Dept. Agr., India, Bot. Series, Vol. IV, No. 3.

(2) THE CHINA COTTONS.

These cottons are also divisible into two groups, one of which is closely allied to the Asiatic group of cottons, and the other to the Upland or *hirsutum* type of America from which country it would appear that they have been imported. Of the relationship of the former group to the better known Asiatic types found in India it is impossible to speak with certainty at present. The question of this relationship is a matter of the utmost difficulty. There appears to have been no critical study of the Chinese cottons in the field, and such information as is available has been derived from herbarium specimens. By Watt* they have been grouped under the name *G. nanking*, and with them he associates certain forms of Indian cottons among which may be mentioned the Bani or Hinganghat cottons. The forms now under consideration compose a compact group of similar forms characterised by a fully sympodial habit, a leaf-factor < 2, entire bracts and a yellow petal. As far as they have been observed, they appear to fall into 4 types.

Plant, stem and leaves, pubescent, petal yellow with a prominent purple eye, seed fuzzy	Type	1
Plant as in Type 1 but with a khaki lint	„	2
Plant glabrous, stem, bracts and bolls showing a marked red tinge or 'burning' on their upper exposed side, seed naked	„	3
Plant similar to Type 3, glabrous, but the red colour found in the vegetative parts of that type entirely absent; petal pure yellow without eye, seed naked ...	„	4

In the plants of this series there occur two characters which are new to the authors in the Asiatic group of cottons. In both

* *Loc.*

Type 3 and Type 4 the seed is naked and in the latter type the purple eye on the petal is also absent. The group of Asiatic cottons constitutes Watt's Section II, Fuzzy seeded cottons with United Bracteoles, and are characterised by, among other points, the "petals with purple claws." If these Chinese forms, which, in general habit, show a distinct similarity to members of the Asiatic group, are here included, the definition of the group breaks down and the united bracteoles alone remain to characterise the group.

The lint of this series shows considerable variation. Of certain plants it is exceedingly coarse and short, rivalling in this respect that of *G. cernuum*, Tod. Of other plants it is long and to a certain degree silky. In no case has any particular crop been found to be uniform in this respect, and it has, therefore, been impossible to obtain a sufficient sample of lint from the plants with a higher grade staple to obtain a valuation. Some of the best are being carried on as single plant cultures, and from these it is hoped subsequently to get valuations.

The entire series of China cottons have been obtained by the courtesy of the Superintendent, Botanical and Forestry Department, Hong-Kong, and may now be briefly described.

1—4 Received from H. B. M.'s Consul, China. Cottons grown in the Shantung Province.

1. From the Ching Ping district.

This cotton proved to be Type 1 with which were mixed a few plants of the American Type.

2. From the Ko Tong Chan district.

This consisted of Type 1 in a condition of purity.

3. From the Lik Chang district.

This was found to consist of a mixture of Type 1 with a few plants of the American type.

4. From the Shan Kwong district.

The crop appeared to be Type 1 in a condition of purity.

5—7. Cottons grown in the Province of Shanghai.

5. Sample labelled Yellow Cotton.

This crop was found to contain mixture of Types 1 and 2 of which the latter greatly preponderated.

6. Sample labelled White Cotton, First Variety.

The crop was entirely composed of Type 1, the individual plants differing only the quality of fibre and the number of leaf glands.

7. Sample labelled White Cotton, Second Variety.

This was indistinguishable from the last.

8. Received from H. B. M.'s Consul, Nanking, and noted as the variety grown in that district.

It proved to be a mixture of Type 1 with a small proportion of the American Type.

9—11. Cotton grown in the Province of Hankow. Of these it is noted that No. 9 is considered the best, 10 the second, and 11 an inferior variety.

9. The crop proved to be a mixture of Types 1 and 3 with the latter preponderating; a single plant of the American type occurred.

10. This again proved to be a mixture of Types 1 and 3, but in this case there occurred a preponderance of Type 1. A single plant of the American type was found in this sample also.

11. This is Type 1 in a nearly pure condition, a small proportion of Type 3 alone being present.

From the constitution of these three samples it would appear that the quality of the lint in bulk depends directly on the proportion of Type 3 found to occur in the crop. The lint of both Types 1 and 3 shows a considerable range of variation from plant to plant.

12 and 13. Cotton grown in the Tchang Province—

12. The crop was found to contain a mixture of Types 1, 3 and 4 with the addition of the American type. Of these, Types 3 and 4 occurred in about equal proportion with a small addition of the American type, Type 1 being represented by a few stray plants only.

13. The sample bore the following note.

"Said to be foreign seed."

The crop was found to consist of the American type only.

(3) THE SIAM COTTONS.

Among the cottons received from Siam three forms only were found to occur.

(1) *G. purpurascens*, Poir. This is a perennial form known under the name of Bourbon or Porto Rico cotton and the present form differs in no way from plants of this type found in India.

(2) *G. brasiliense*, Macf. The Kidney Cotton. A perennial form, characterised by the fact that the seeds of each cell are united.

(3) The third form is a plant with a fully developed monopodial habit and is cultivable as a perennial. It contains a series of types which appear to be most closely related to, and may be identical with, certain of the cottons grown in Behar and Bengal proper. This group of cottons, which are included in Gammie's group *G. intermedium*, Tod, have, owing to their late habit, not been fully investigated; and the types, of which, as grown in Behar and the East of the U. P., it undoubtedly includes more than one, have not been isolated and grown in pure culture. It is therefore impossible at the present moment to specify this cotton in greater detail.

1. Cotton from the Petrin district.

This sample was composed entirely of *G. purpurascens*, Poir.

2. Cotton from Kampeng district.

This contained the series of monopodial forms above mentioned as allied to *G intermedium*, Tod.

3. Faitade or Common Siam Cotton.

The Kidney Cotton, *G. brasiliense*, Macf.

PLATES.

I. Monopodium and sympodium of approximately equal vigour arising at second node of sympodium.

II. Sympodial branch of *G. cernuum*, Tod. Showing development of accessory bud at first node into a monopodium.

III. A sympodial branch giving monopodia at the second and subsequent nodes.

IV. A complex branch with a weak monopodium developed at second node, and monopodium and sympodium of equal vigour at the third node.

V. A complex branch, the monopodium developed at second node of sympodium of more vigorous growth than the sympodium and giving a series of sympodia from successive nodes.

VI. The accessory bud giving monopodium.

VII. The first node of a sympodial secondary branch from which the accessory bud apparently gives rise to sympodium. The first leaf and terminal bud of the undeveloped monopodium are visible.

PLATE I.

PLATE II.

PLATE III.

PLATE IV.

PLATE V.

PLATE VI.

PLATE VII.

APPENDIX.

*Rainfall in mms.**

Names of places.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	TOTAL.
Cairo	9	5	4	2	1	..	...	...	...	1	4	6	32
Isphahan	19	13	32	16	11	...	...	...	...	6	20	13	130
Tehran	46	28	48	36	13	2	1	1	1	9	32	34	251

Average mean monthly temperatures. Adapted from J. Hann's Handbuch der Klimatologie.

Cairo	54	57	62	70	77	82	84	82	78	71	65	58	...
Isphahan	32	42	47	60	69	77	82	78	72	61	48	42	...
Tehran	33	42	48	61	71	80	85	83	78	66	51	42	...

* Kindly supplied by the Director-General of Observatories, Simla.